UKOPA

United Kingdom Onshore Pipeline Operators' Association

# Good Practice Guide

# Pipeline Hazard Distances

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## GUIDANCE ISSUED BY UKOPA:

The guidance in this document represents what is considered by UKOPA to represent current UK pipeline industry good practice within the defined scope of the document. All requirements should be considered guidance and should not be considered obligatory against the judgement of the Pipeline Owner/Operator. Where new and better techniques are developed and proved, they should be adopted without waiting for modifications to the guidance in this document

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## Disclaimer



## Revision and change control history

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| 1 | April 2017 | 10 | Developed based on UKOPA research for Hazard Distances |
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| | | | |

# CONTENTS

# 1 INTRODUCTION

This UKOPA good practice guide identifies the emergency hazard distances for pipelines; that is, the distance that the inner cordon should be set in an emergency situation if a pipeline ruptures. Different figures apply to the type of fluid that is being transported in the pipeline. The hazard distances for natural gas, ethylene and liquid hydrocarbons are given in the appendices of this document with brief explanations.

This guidance does not remove or replace the technical expertise or knowledge of Pipeline Operators but has been developed to assist local authorities and other interested parties who may require consistent and grounded information in the development and instigation of emergency plans linked to pipeline operations.

> *Regulation 25 of The Pipelines Safety Regulations 1996 [1], places a number of requirements on Local Authorities and Pipeline Operators, (including, but not limited to, the need to prepare an emergency plan and review it at least every three years for Local Authorities and the need to provide information on Major Accident Hazard Pipelines in order to prepare the plan for Pipeline Operators).*

The good practice in this guide also identified the emergency planning distance (known as the thermal hazard range) which will be provided by pipeline operators to local authorities in order to comply with the requirements of the Pipelines Safety Regulations [1].

# 2 SCOPE AND APPLICATION

## 2.1 Scope

The guidance in this document is applicable to buried pipelines operated by the UKOPA member companies containing the following fluids.

- Natural gas
- Ethylene
- Liquid Hydrocarbons

## 2.2 Application

The guidance in this document represents what is considered by UKOPA to be current UK pipeline industry good practice within the defined scope of the document. All requirements should be considered to be guidance and should not be considered to be obligatory against the judgement of the responsible engineer. Where new and better techniques are developed and proved, they should be adopted without waiting for the modification to the guidance in this document.

Within this document:

**Shall:** indicates a mandatory requirement.

**Should:** indicates good practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment must be completed to show that the alternative method delivers the same, or better, level of protection.

## 3 HAZARDS OF PIPELINES FAILURE

A pipeline failure could lead to a range of hazards, dependent on the fluid being carried. These could include (but are not limited to).

- Thermal radiation
- Toxic cloud (including vapour)
- Debris
- Noise
- Over pressure (for gas pipelines, caused by the decompression of the gas as it initially escapes from the leak and also as a result of flame propagation if the gas cloud ignites)

The determination of the pipeline emergency hazard distance and the emergency planning distance should take account for the worst-case hazard for the particular fluid being conveyed.

In this document, all figures quoted assume a generic worst-case scenario for each product and thus provide an initial emergency hazard distance. Once Pipeline Operator personnel arrive on site, distances should be revised based on the site situation and conditions and technical advice.

The emergency planning distances quoted are for use by local authorities when preparing their emergency plans.

# 4 TYPICAL HAZARD DISTANCE DEFINITIONS

The following definitions are used to describe distances associated with pipeline hazards.

## 4.1 Thermal Hazard Range (Emergency Planning Distance)

The thermal hazard range is the maximum distance away from the pipeline where it is calculated that individuals could come to harm as a result of a pipeline failure.

The thermal hazard ranges for gas pipelines assume a full-bore pipeline failure (rupture). These distances should be used by local authority emergency planners when preparing the local emergency plan for major accident hazard pipelines (MAHPs).

The thermal hazard range for liquid hydrocarbon pipelines is based on the spray distances from a hole discharging the full pipeline flowrate. For liquid hydrocarbon pipelines not classified as MAHPs, this distance should be used by the emergency services when responding to incidents

## 4.2 Emergency Hazard Distance (Inner Cordon)

The emergency hazard distance is the thermal hazard range plus a safety factor. This is the distance that the inner cordon should be established in a first response to an emergency situation if there is a pipeline rupture. When Pipeline Operator personnel arrive on site, they will be, able to advise whether it is appropriate to reduce this distance.

## 4.3 Incident control points (Outer Cordon)

If incident control points are being set up, it is suggested that these should be established at a suitable distance outside the inner cordon and determined by the Fire and Rescue Service in collaboration with the pipeline operator. NB this may be different based on the pipeline operator and dependent upon the pressure and product in the pipeline.

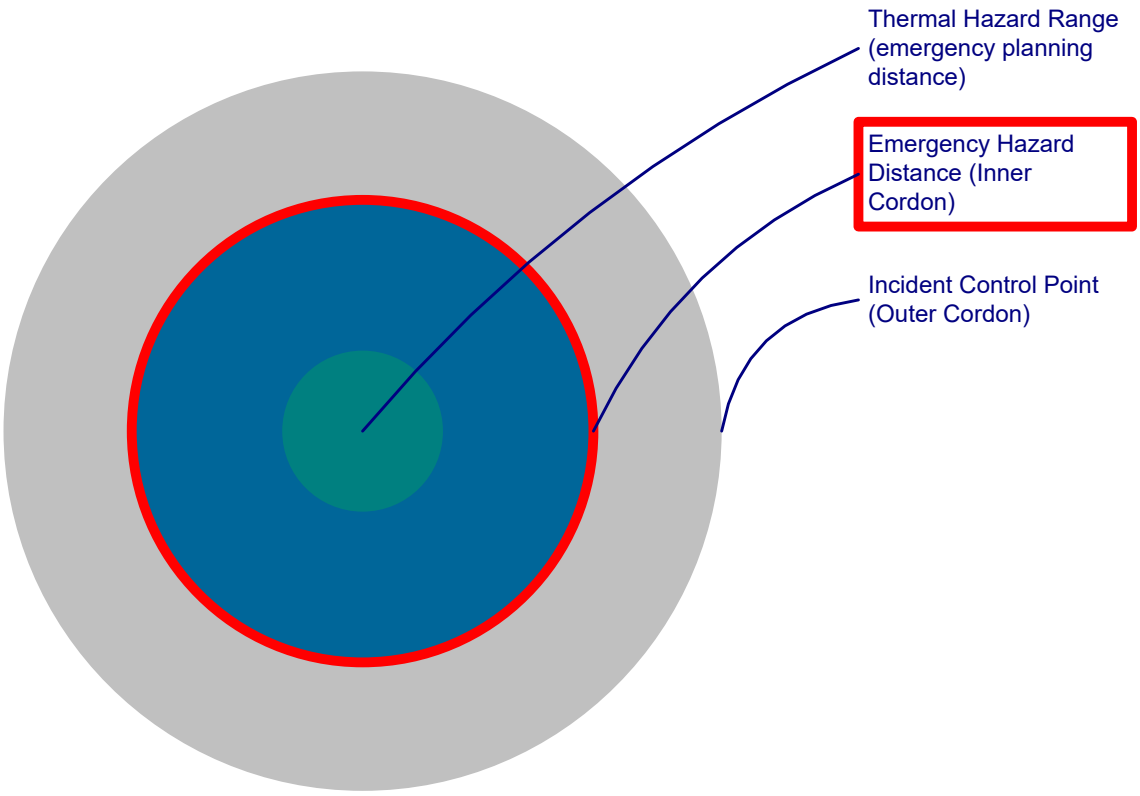


*Figure 1 Diagram identify emergency planning distance, inner cordon and outer cordon*

*(NB these definitions may vary slightly based on the specific pipeline operator)*

The appendices that follow identify the emergency hazard distances or inner cordon for the different fluids transported by UKOPA member companies.

# 5 REFERENCES

[1] HSE, The Pipelines Safety Regulations 1996 (SI 1996/825), 1996.

[2] R. McConnell, "Recommended Emergency Planning Distances for Hydrocarbon Liquids," UKOPA, 5 March 2012.

## 5.1 Bibliography

1. HSE Document, Further guidance on emergency plans for major accident hazard pipelines, The Pipelines Safety Regulations 1996, ISBN 0 7176 1393 3

2. Recommended Ethylene Emergency Planning Distances, 18 June 2013, report prepared by R McConnell for UKOPA

## APPENDIX A HAZARD DISTANCES FOR NATURAL GAS

The recommended emergency hazard distance is the distance from a pipeline for which a detailed emergency plan has to be prepared for the “worst credible” or reference accident.

A pipeline failure could lead to a range of hazards, the principal ones being:

- Debris
- Noise
- Over pressure (caused by the decompression of the gas and because of flame propagation if the gas cloud ignites)

However, by far the most significant in terms of hazard ranges is the effect of thermal radiation should the gas subsequently ignite.

There can be a sequence of events starting from immediate ignition, to delayed local ignition, through delayed remote ignition, to no ignition at all. Each can have different consequences, hazard ranges and durations but there is an inter-dependency and for this reason timescale and sequence should be considered

If a release occurs that does not initially ignite, then the local authority’s plan should recognise that ignition of the gas could potentially occur at any time. Steps should be taken to ensure that potential ignition sources are not introduced into the area around the release where gas could potentially be present in flammable concentrations. The extent of the flammable gas cloud is difficult to predict, as it is dependent on the release pressure, size and orientation of the release and the atmospheric conditions.

Not all of natural gas major accident hazard pipelines (MAHP) contain gas that is odorised (i.e. contain the characteristic smell of leaking gas). It should **not** therefore be assumed that if gas cannot be smelt that individuals are at a safe distance.

***Note:*** *For a high-pressure pipeline failure, flammable gas concentration readings are not a reliable indication of a safe evacuation distance. If the leaking gas jet ignites, the resulting thermal radiation could cause injury at distances well beyond the distance that gas would be present in flammable concentrations at ground level*

**It is therefore recommended that the emergency hazard distance or inner cordon for natural gas pipelines should be initially conservatively set at using the table below.**

| Size or pressure of pipeline | Emergency hazard distance / Initial inner cordon |
|---|---|
| 1219mm AND > 70 bar g | 900 metres |
| > 610mm OR > 40 bar g | 750 metres |
| ≤ 610mm OR ≤ 40 bar g | 500 metres |

*Table 1 Natural gas hazard distances*

## APPENDIX B HAZARD DISTANCES FOR ETHYLENE

The recommended emergency hazard distance or inner cordon is the distance from a pipeline for which a detailed emergency plan has to be prepared for the “worst credible” or reference accident.

Ethylene emergency hazard distances have previously been based on a single declared distance derived from either risk zones from an ignited release or dispersion distances from a non-ignited release [2].

The “worst case” credible scenario for ethylene pipelines is ignition soon after pipeline rupture causing a fireball. Hazard distances to vulnerable population (700 thermal dose units or tdu) for UK pipelines operating at 99barg vary from 120 metres to 200 metres depending on pipeline diameter, as shown below.

| Pipeline diameter (mm) | Thermal hazard range | |
|---|---|---|
| | 1000 tdu Fireball hazard distances (metres) | 700 tdu Fireball hazard distances (metres) |
| 219 | 100 | 120 |
| 273 | 140 | 165 |
| 324 | 170 | 200 |

*Table 2 Ethylene hazard distances*

Modelling of immediate and delayed ignition jet fire events shows that, even for the rupture cases, hazard distances are smaller than the fireball hazard distances.

Other scenarios developed for the non-ignited rupture event causing a plume of flammable vapour to disperse downwind are considered non-credible for emergency hazard purposes. Modelling of these plumes shows that by the time they have developed downwind from the release point, the release rate from the pipeline has reduced to such an extent that any potential flash fire event would be within 250 metres from the release point for most wind/weather conditions. In any case, the probability of ignition is considered very low, much lower than for the fireball or jet fire event.

Similarly, plume dispersion from non-ignited stable leaks (i.e. less than 50mm diameter) results in flammable distances, which are smaller than the 200 metres maximum fireball hazard distance.

**It is therefore recommended that the emergency hazard distance or inner cordon for dense phase ethylene pipelines should be conservatively set at 250 metres.**

# APPENDIX C HAZARD DISTANCES FOR LIQUID HYDROCARBON

## C.1 Liquid MAHPs

The recommended emergency hazard distance or inner cordon is the distance from a pipeline for which a detailed emergency plan has to be prepared for the “worst credible” or reference accident.

For liquid hydrocarbon pipelines classed as MAHPs (i.e. spiked crude, natural gas liquid (NGL) pipelines, etc), the assumed consequence model for sprays covers an approximately elliptical area. The analysis showed that the maximum range of the jet/spray is theoretically proportional to pressure, so the guidance is that:

Range of spray in metres = 2 x pressure in barg

Therefore, the maximum thermal range distances should be applied as follows:

| Maximum operating pressure (barg) | Maximum thermal hazard range (metres) |
|---|---|
| 40 | 80 |
| 50 | 100 |
| 60 | 120 |
| 70 | 140 |
| 80 | 160 |
| 90 | 180 |
| 100 | 200 |

*Table 3 Liquid hydrocarbon maximum hazard ranges*

**It is therefore recommended that the emergency hazard distance or inner cordon for liquid hydrocarbon pipelines should be conservatively set at 250 metres**.

**Note**: The topography of the surrounding area of the leak may need consideration. If the liquid is identified as traveling from initial rupture site, then emergency hazard distances must be applied along the entire leak path.

## C.2 Liquid Non MAHPs

The “worst case” credible scenario for oil pipelines, which are not classed as MAHPs, is ignition a few minutes after pipeline rupture causing a pool fire. Hazard distances to vulnerable population (700 thermal dose units or tdu) for UK pipelines operating at 100barg vary from 35 metres to 75 metres depending on pipeline diameter, as shown below.

| Pipeline diameter (mm) | Thermal hazard range | |
|---|---|---|
| | 1000 tdu Pool Fire hazard distances (metres) | 700 tdu Pool Fire hazard distances (metres) |
| 168 | 30 | 35 |
| 273 | 45 | 55 |
| 324 | 50 | 60 |
| 508 | 65 | 75 |

*Table 4 Oil pipelines hazard distances*

These distances are from a pool fire assuming non soaks into the ground, and the pool is circular and spreads in all directions. Evidence from actual events shows that some oil will soak into the ground and that oil pipeline accidents are unlikely to ignite.

Note the topography of the surrounding area of the leak may need consideration to allow for non-flat areas. If the liquid is identified as traveling from initial rupture site, then emergency hazard distances must be applied along the entire leak path. A safety factor of 2 is applied to the distances shown above to allow for non-flat topography.

Other scenarios developed for pipeline holes causing a spray of flammable liquid droplets and vapour are considered non-credible for emergency hazard purposes. Modelling of these sprays shows that most spray events are within the proposed emergency planning distance.

**It is therefore recommended that the emergency hazard distance or inner cordon for liquid hydrocarbon pipelines should be conservatively set at 150 metres.**